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**University of Saskatch**
**College of Engineeri**

**EE 441: Power Systems II**
**Final Examination**
***A one formula sheet is allowed***

**Instructor: S.O. Faried** **December 7, 2002**
**Duration: 3 hours**

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1- Consider the power system shown in Fig. 1. Use a power base of 500 MVA and network reduction to calculate the fault current in Amperes and the line-to-line voltages at the fault point for a sustained single line-to-ground fault at bus D.

$G_1$ : 500 *MVA*, 13.8 *kv*, $x_d'' = 0.2$ *p.u.*, $x_2 = 0.2$ *p.u. and* $x_o = 0.1$ *p.u.*

$G_2$ : 600 *MVA*, 26 *kv*, $x_d'' = 0.15$ *p.u.*, $x_2 = 0.15$ *p.u. and* $x_o = 0.1$ *p.u.*

$G_3$ : 400 *MVA*, 13.8 *kv*, $x_d'' = 0.2$ *p.u.*, $x_2 = 0.2$ *p.u. and* $x_o = 0.1$ *p.u.*

$T_1$ : 500 *MVA*, 13.8 *kv* / 500 *kv* , $x = 0.1$ *p.u.*

$T_2$ : 600 *MVA*, 26 *kv* / 500 *kv*, $x = 0.1$ *p.u.*

$T_3$ : 500 *MVA*, 13.8 *kv* / 500 *kv*, $x = 0.1$ *p.u.*

$Line_{AB}$, $x_1 = 50\ \Omega$

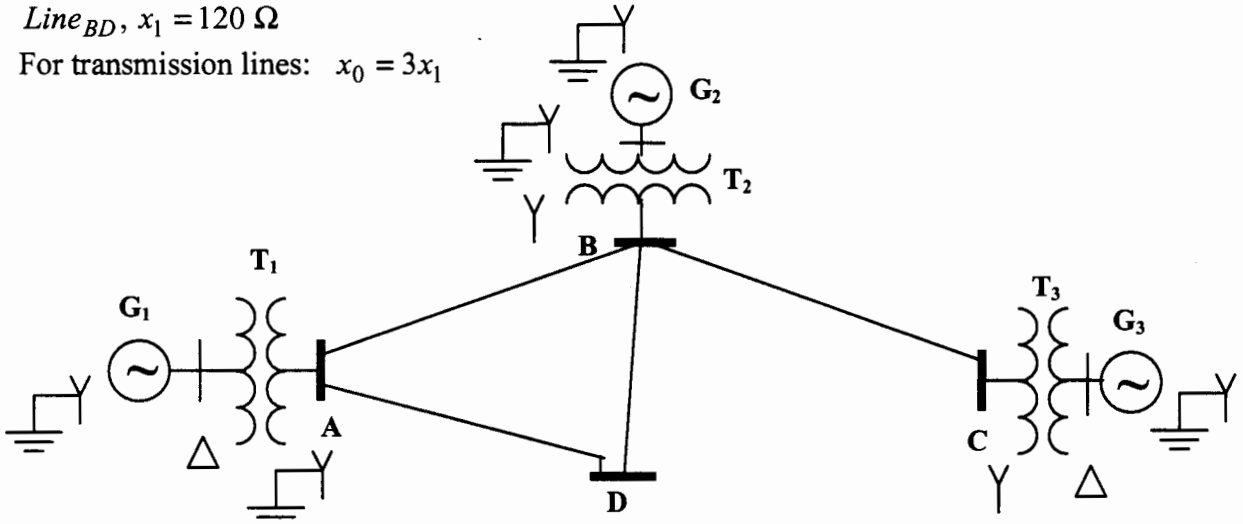
$Line_{BC}$, $x_1 = 80\ \Omega$

$Line_{AD}$, $x_1 = 80\ \Omega$

$Line_{BD}$, $x_1 = 120\ \Omega$

For transmission lines: $x_0 = 3x_1$

Midterm : Solve above using bus admittance matrix. Calculate bus voltage at bus A




10000 MVA short circuit capacity

$x_{1system} = x_{2system}$, $x_{0system} = 0.5\, x_{1system}$

Fig. 1

**(12 Marks)**

2. The data of the sample power system shown in Figure 2 are given in Tables 1 and 2. Using Gauss-Seidel iterative algorithm, perform 2 iterations and check the convergence after each iteration. Use a voltage magnitude tolerance of 0.001, an acceleration factor of 1.6 and 100 MVA base.

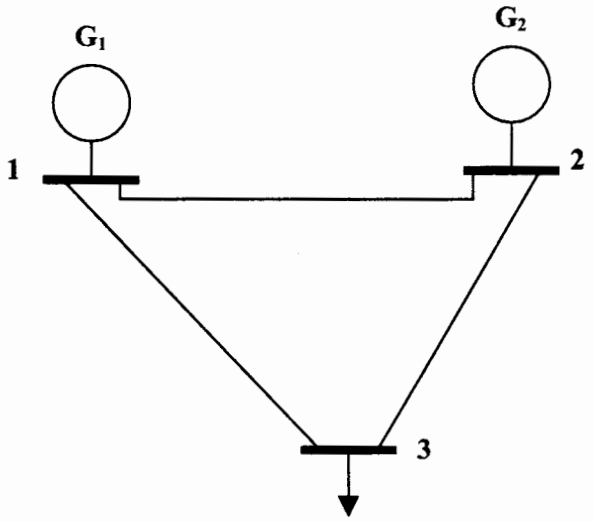



Fig. 2

Table 1: Impedances of the sample power system in p.u. on a 100 MVA base

| Bus Code: p - q | Impedance $Z_{pq}$ | Line charging $0.5Y_{pq}$ |
|---|---|---|
| 1-2 | $0.04 + j0.16$ | $j0.15$ |
| 1-3 | $0.02 + j0.08$ | $j0.07$ |
| 2-3 | $0.05 + j0.12$ | $j0.08$ |

Table 2: Scheduled generation and loads and magnitudes of bus voltages for the sample power system.

| Bus code p | Bus voltage | Generation | | Load | |
|---|---|---|---|---|---|
| | | MW | MVAR | MW | MVAR |
| 1 | 1.04 | ? | ? | 0 | 0 |
| 2 | 1.02 | 40 | ? | 0 | 0 |
| 3 | ? | 0 | 0 | 100 | 40 |

**(12 Marks)**

3. In the system shown in Figure 3, a three-phase fault occurred on one of the transmission lines just after the circuit breaker. Find the following:
   (a) The critical clearing angle in degrees.
   (b) The critical clearing time in seconds.
   (c) The generator speed at the instant of clearing in radians per second.

$$x'_d = j0.4 \text{ p.u.}, \quad x_{T.L} = j0.8 \text{ p.u.}, \quad x_{T_1} = x_{T_2} = j0.1 \text{ p.u.}, \quad M = 7 \text{ sec}$$

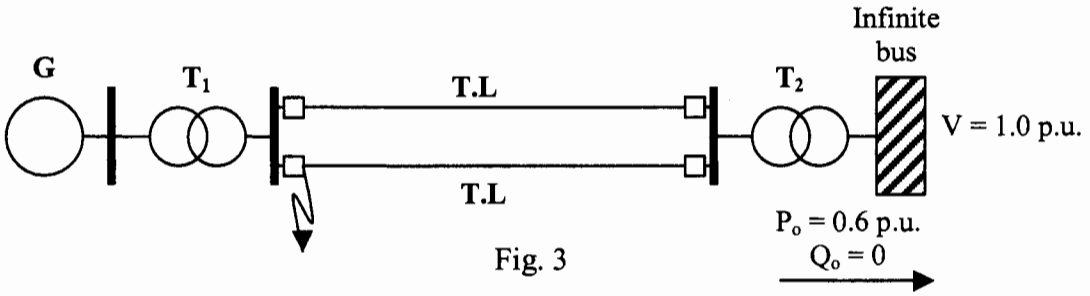



Fig. 3

**(12 Marks)**

4. In the system shown in Figure 4, a three-phase fault occurred on one of the transmission lines at the middle point. The switch S is opened simultaneously with circuit breakers A and B. Find the critical clearing angle.

$x'_d = j0.4$ *p.u.*, $X_C = -j0.1$ *p.u.*, $x_{T.L} = j1.0$ *p.u.*(*each of the four sections*)

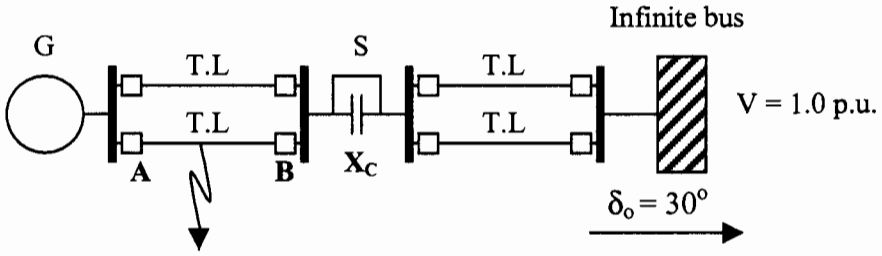



Fig. 4

**(12 Marks)**

5. Consider the system shown in Figure 5. Using the equal area criterion, discuss whether the transformer neutral reactance $X_{T_g}$ improves or degrades the system transient stability.

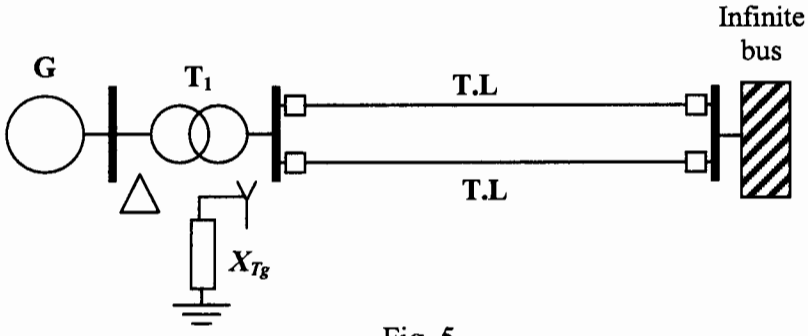



Fig. 5

**(6 Marks)**

6. Consider the system shown in Figure 6. Find the synchronizing power and the natural frequency of free oscillations.

$x_d = j1.0$ *p.u.*, $x_{T.L} = j0.8$ *p.u.*, $x_{T_1} = j0.1$ *p.u.*, $x_R = j0.5$ *p.u.*, $M = 7$ sec

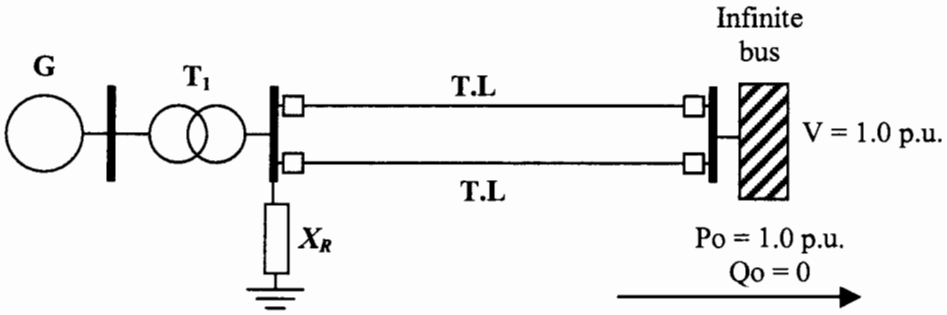



Fig. 6

**(6 Marks)**